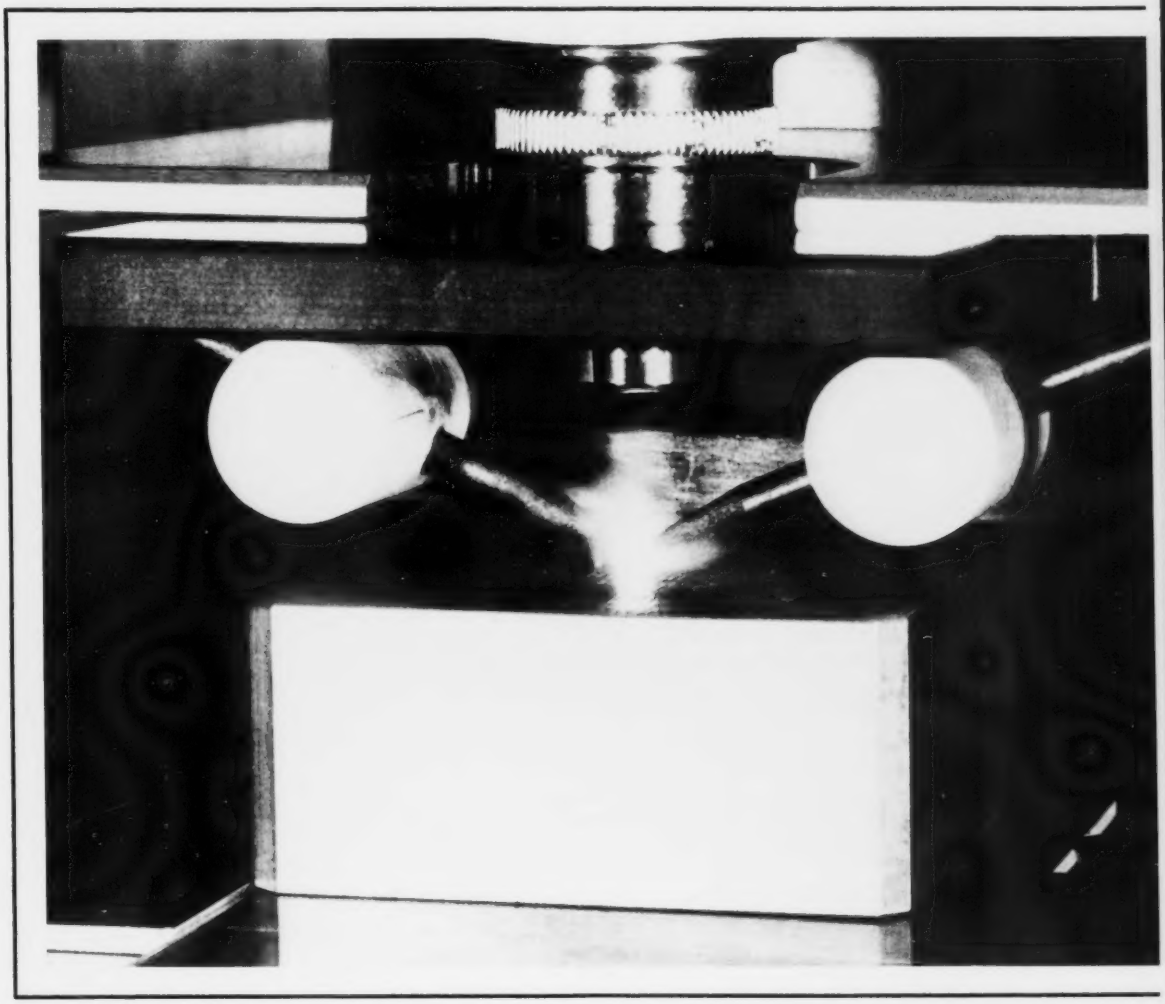
NATIONAL BUREAU OF STANDARDS November/1967

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

TNB Technical News Bulletin

NOVEMBER 1967/VOL. 51, NO. 11/ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
Alexander B. Trowbridge
Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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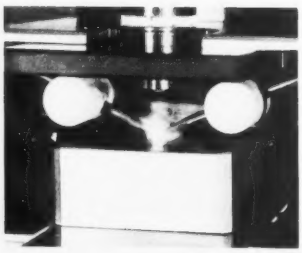

COVER

Spark excitation of laser-produced vapor aids spectrochemical analysis.
(*See p. 239.*)

Prepared by the NBS Office of Technical Information and Publications
Washington, D.C. 20234
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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Subscription price: Domestic, $1.50 a year; 75 cents additional for foreign mailing; single copy, 15 cents. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 19, 1961).

Library of Congress Catalog Card Number: 25–26527

SPECTROCHEMICAL ANALYSIS BY LASER-PROBE EXCITATION

S. Rasberry prepares the laser probe apparatus for an analysis.

■ One of the many applications of the laser is its use in spectrochemical analysis. In this application, a high-energy laser beam is focused on a specimen, vaporizing a small sample. By further exciting the vapor with a spark discharge, emission spectra may be obtained. The wide range of laser-probe analytical applications includes analyses of microsamples, thin films, small wire, and particles imbedded in specimens. The technique appears to be particularly well suited for analyses of microsamples and nonconductors because optical rather than electrical power is used for vaporization.

In a recent study,[1] S. D. Rasberry, B. F. Scribner, and M. Margoshes, of the NBS Institute for Materials Research, investigated the capabilities of a laser-probe analytical system. Analytical data were obtained for a variety of specimens. In addition, the effects of a wide range of experimental conditions were evaluated.

The laser-probe apparatus used in the NBS study has as its main components a control console, a Q-switched ruby laser, a microscope, and an electrode system with separate spark power supply. A synthetic ruby rod with 0.05 percent Cr^{+3} doping is the principal component in the laser; it is 5.7 cm long by 0.5 cm in diameter, and has end surfaces cut and polished at Brewster's angle. Reflectors for the laser cavity are free stand-

continued

LASER PROBE *continued*

ing from the rod; the back reflector rotates and produces nearly 100 percent reflection for only a few hundred nanoseconds in each cycle. A helical xenon flashlamp optically pumps the laser rod. It is centered axially in a cylindrical reflector to increase pumping efficiency.

The laser output is coherent, monochromatic (6943 Å) radiation of very high power and short duration. When the beam is focused on a specimen by the microscope, between 0.01 and 1.0 μg of the sample is vaporized from a region 35 to 150 micrometers in diameter. When a part of the partially ionized vapor reaches the electrode gap of the spark power source, the resistance is lowered sufficiently for a spark to be automatically discharged. The emission of the atoms and ions returning to a lower energy level is then recorded photographically on a grating spectrograph.

Data were obtained for the construction of analytical curves for more than a dozen elements in a variety of matrices including low-alloy steels, high-alloy steels, high-temperature alloys, and pellets of powdered talc. The measurements were made over a range of experimental conditions, including one- and four-spike laser operations and one to five superimposed exposures.

Analytical curves for the alloys were plotted with the intensity ratio versus the concentration ratio. Data obtained from analysis of the high-temperature alloys indicate that laser-probe excitation may be relatively free from matrix effects.

The investigation showed that imprecision results largely from variations in laser energy and from photometric errors. In addition, the parameters of the spark circuit were found to affect the spectral line intensities. It was also found that correlations exist between the energy of the laser beam, size of pit formed by vaporization, and spectral intensities. Further, single-spike operation was preferable to multiple-spike operation in cases where good precision was required.

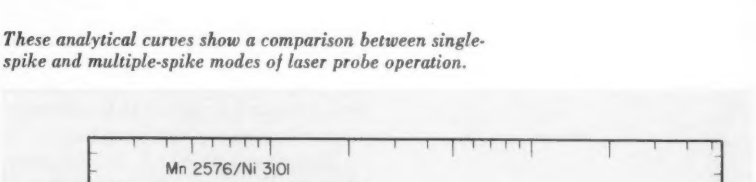
The useful ranges of the spark circuit parameters for producing a spectrum were examined. The results showed an increase in spectral intensity as the voltage was increased. The intensity decreased, however, as the inductance or the resistance was increased. Raising the capacitance resulted in an increase in line intensity. The capacitance parameter had the greatest influence on line intensity.

In single-spike operation the peak power and total energy of the laser pulse were fairly reproducible, with coefficients of variation of approximately 10 percent. Operation with multiple spikes was much less reproducible. It appeared that laser pulse reproducibility was more of a controlling factor for precision of line intensity than the spark-circuit parameters. However, other factors can increase analytical imprecision.

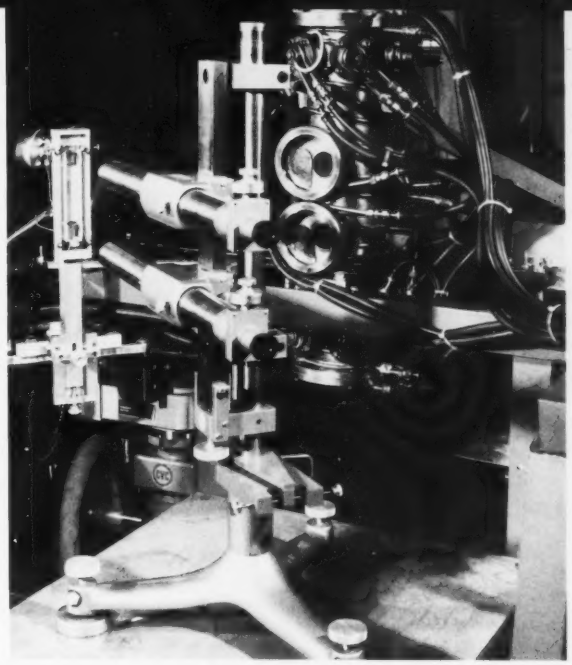
The effect of the auxiliary spark was to produce sharper spectral lines that were more intense (than non-spark excited spectra) by a factor of approximately 15. Laser-plus-spark excitation gave spectra that were sufficiently intense to permit detection of between 10 and 50 pg (1 to 5×10^{-11} g) of those elements for which spectrochemical analysis is sensitive. Without spark excitation, the spectra contained lines of the major constituents which could be self-reversed and resonance-broadened to half-widths as great as 5 Å.

The system described yielded coefficients of variation for analyses of 15 to 40 percent. This is adequate, in many cases, for the identification of minute samples. However, continuing investigations are planned to reduce this variation and to increase the capabilities of the laser-probe analytical system.

These analytical curves show a comparison between single-spike and multiple-spike modes of laser probe operation.



[1] For further information, see **Laser probe excitation in spectrochemical analysis: I. Characteristics of the source**, by S. D. Rasberry, B. F. Scribner, and M. Margoshes, Appl. Opt. **6**, 81–86 (1967). See also, **Laser probe excitation in spectrochemical analysis: II. Investigation of quantitative aspects**, by S. D. Rasberry, B. F. Scribner, and M. Margoshes, Appl. Opt. **6**, 87–93 (1967).



Accurate measurements of thermal expansion are made by focusing the microscopes on specimen fiducial marks (inside heater), then rotating the microscopes to make a comparison measurement with a length scale (left) at room temperature.

APPARATUS MEASURES THERMAL EXPANSION AT HIGH TEMPERATURE

■ Accurate data on the thermal expansion of solids at high temperatures (above 1000 °C) are needed for many areas of research and technology. Such high-temperature data are essential in the study of lattice defects, phase transitions, behavior of spacecraft components, and for reference materials used in comparison measurements of other specimens.

To provide data on reference materials, B. D. Rothrock and R. K. Kirby of the NBS Institute for Basic Standards have developed apparatus for accurate determination of thermal expansion on refractory materials at temperatures up to 1600 °C.[1] The apparatus consists of a controlled gradient furnace and an optical comparison measuring system that gives expansion data accurate to within 50 ppm (parts per million).

Basically the system compares the length of a specimen with that of a reference scale at room temperature. This is accomplished by means of two microscopes mounted on an invar bar. The microscopes can be raised, lowered, or rotated as a unit about a vertical axis. By setting the crosshairs of the microscopes on fiducial marks in the specimen, then rotating the microscopes to the reference scale, accurate comparisons are obtained.

NBS has designed and constructed a furnace to produce uniform temperature along the length of the specimen. The temperature gradient is controlled by five individually controlled heating sections obtained by tapping an evenly wound resistance heater at 5 cm intervals. By the use of isolation transformers, the power in any one section may be varied, with a negligible change in power in the remaining sections. Thus, compensations may be made for end heat losses.

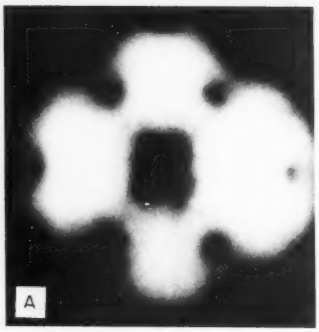
The furnace has a centrally located heating core consisting of an alumina tube wound with rhenium wire. Inside this heating core is another high-purity alumina tube in which control and measuring thermocouples are positioned. An outer stainless steel shell is water cooled and vacuum sealed.

The specimen is suspended by tungsten wire inside the heater core and thermocouple protection tube. Two windows on one side provide a means for focusing the microscopes on the specimen fiducial marks. A third window, on the opposite side, allows temperature comparison between the measuring thermocouples and an optical pyrometer.

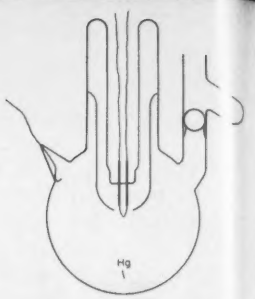
For highest accuracy, the fiducial marks must be an integral part of the specimen. For a platinum specimen, satisfactory marks were made by first drilling a hole of 1.73 mm to within 0.25 mm of penetrating a milled flat on the opposite side. From the opposite side a smaller hole was then drilled coaxial with the first. This left a thin ring around the inside of the hole and a small nick was cut in the ring with a hardened steel ruling edge. In the case of a sapphire specimen, a local area was ground until a thin ridge was left, the faces of which were parallel to the axis of the specimen. A small nick was then placed in the ridge with a carbide disk.

After numerous experiments with the apparatus, data analysis indicates that both the platinum and sapphire measurement uncertainty should be within 30 micrometers at 800 °C and within 50 micrometers for temperatures up to 1600 °C.

[1] For further details, see **An apparatus for measuring thermal expansion at elevated temperatures**, by B. D. Rothrock and R. K. Kirby, J. Res. NBS 71C (Engr. and Instr.), No. 2, 85 (Apr.–June 1967).

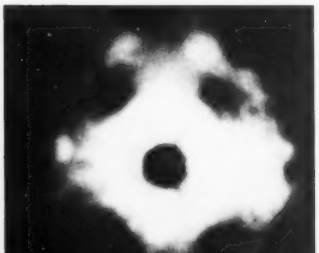


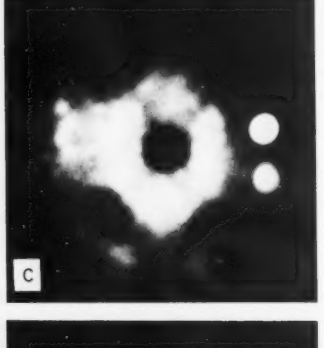
Micrographs of the field emission emitter during nucleation of mercury on tungsten show the tungsten emitter before (A) and after exposure to mercury flux for 39 (B), 40 (C), and 43 (D) minutes. After about 40 minutes of mercury deposition, small areas of intense emission develop about the close packed faces.



Field emission microscope used to determine the critical coverage required to form nuclei as a function of impingent flux at 77 °K.

NUCLEATION OF MERCURY ON TUNGSTEN STUDIED BY FIELD EMISSION MICROSCOPY





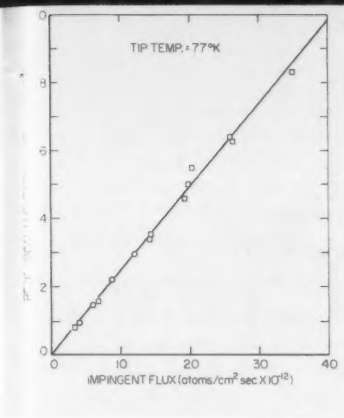
■ Increasing emphasis is being placed on basic studies of metallic structures. Such studies yield valuable information on mechanical properties and the origin of defects in metals. In this work it is important to understand the phenomena that occur during crystallization and nucleation.

To obtain basic information on metal phase transformation, S. C. Hardy of the NBS Institute for Materials Research recently conducted a low-temperature study of the nucleation of mercury on tungsten by field emission microscopy.[1] This work, supported in part by the Advanced Research Projects Agency, has shown that at 77 °K the critical coverage for forming nuclei is about four monolayers, independent of impingent flux. This multilayer critical coverage is in striking contrast to the theoretically expected dilute layer. At higher temperatures, a temperature-dependent critical supersaturation was observed that agrees with the predictions of a model with disk-shaped nuclei. At lower temperatures the results are in general agreement with previous observations of metal nucleation on tungsten field emitters.

In the NBS study of nucleation, a field emission microscope was used because of its operation in an ultra-high vacuum, its large magnification (10^5X), and its high resolution (50 Å). An additional advantage was provided by the single-crystal emitter, which could be cleaned of adsorbed gases by flashing to high temperatures.

The field emission microscope operates on the principle that when a high-electric field is established at a metal-vacuum interface, the potential barrier keeping the electrons in the metal is reduced and the electrons can pass from the metal into the vacuum. The high fields are generated by creating a large potential in an extremely sharp metal tip. The metal tip then serves as the emitter. In this study the emitter was made of tungsten and also served as the substrate for the formation of mercury nuclei from the mercury vapor. After the nuclei were formed, the field was applied, causing electrons to be emitted. The emitted electrons then formed an image of the emitter surface, and hence of the formation of mercury nuclei on a fluorescent screen.

During the course of the study, it



The formation of mercury nuclei on tungsten is a function of impingent flux at 77 °K; the straight line indicates that critical coverage is independent of impingent flux.

was found that the fields required to form an emission pattern (approximately 10^7 volts per centimeter) could change the concentration of mercury at the emitter tip by field-enhanced surface diffusion up the shank of the emitter. To reduce this effect, the field was applied only when the emitter temperature was near 77 °K, the field was applied only long enough to examine the image, and the field was kept near the minimum imaging value.

To meet these requirements, the experiments were divided into two related groups. The first involved measurements of the critical coverage required to form nuclei as a function of impingent flux at 77 °K. In the second group, measurements were made to determine the critical supersaturation required to form nuclei at higher temperatures.

In the first group of experiments, the time required to form the first nuclei, starting with a clean emitter at 77 °K, was measured as a function of impingent flux. The time was found to be inversely proportional to the flux indicating that the critical coverage for nucleation is independent of impingent flux. The slope of the line indicates a critical coverage for nucleation of approximately 4 x 10^{15} atoms per square centimeter. This constitutes about four monolayers of mercury.

In the microscope used in the first experiments, the mercury was located at the bottom of a spherical bulb. A cold finger and the major part of the emitter loop were separated from the mercury vapor source by a glass shield attached to the outer wall of the bulb body. In operation, the cold finger was filled with liquid nitrogen and the microscope immersed in an isothermal bath of stirred alcohol cooled with dry ice in an unsilvered Dewar. The bath was continuously monitored with a thermocouple and the temperature maintained by adding small amounts of dry ice.

The flux of atoms to the emitter tip at 77 °K was calculated using the equilibrium pressure of bulk mercury at the bath temperature as the pressure at the tip. This assumption has been justified empirically. Thus, the absolute flux of mercury atoms to the tip was known, but the range over which the flux could be varied and controlled was narrow.

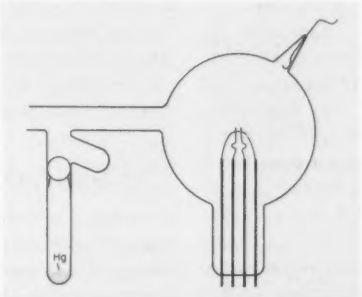
In the second group of experiments, the time required for formation of the first nuclei was plotted as a function of emitter temperature over a range of impingent fluxes. The impingent flux of mercury atoms at the tip was empirically determined by measuring the time required to form nuclei and referring to data on nucleation time as a function of flux taken with the first microscope. The curves obtained are characterized by a gradual rise followed by an abrupt upward turn occurring at progressively higher temperatures as the flux is increased. This large increase in nucleation time at a well defined temperature arises from the equilibration of impingent and desorption fluxes. It is interpreted as defining a critical supersaturation for the formation of Hg nuclei.

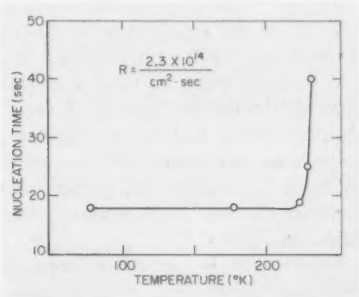
The second microscope was designed to permit a wide flux range with good control and a variable emitter temperature. Its mercury reservoir was located at a distance from the emitter and could be isolated with a ball valve. The cold finger and press were not shielded in the second microscope. At 77 °K they quickly reduced the pressure of mercury in the microscope body to an inappreciable value when the valve was closed. The mercury temperature in the reservoir was controlled by a double Dewar system. The emitter temperature was controlled by immersing the cold finger in liquid nitrogen and passing a small heating current through the loop.

To control the flux, temperature stability was first obtained, then the valve was opened and the tip exposed to a known flux of mercury atoms. The valve was then closed and the heating current to the loop stopped after the desired dosage. The process was repeated at the next selected temperature.

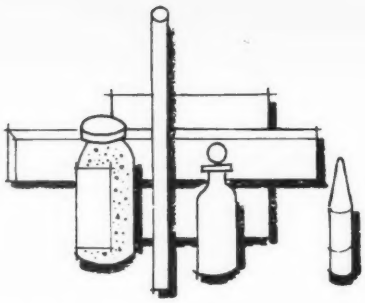
[1] For further details, see The nucleation of Hg on W by field emission microscopy, by S. C. Hardy, Crystal Growth, Suppl. to J. Chem. Phys. Solids, 287 (1967).

(Left) Field emission microscope used to determine the critical supersaturation required to form nuclei at higher temperatures. (Right) The large increase in nucleation time of mercury on tungsten at a well defined temperature is interpreted as defining a critical supersaturation for the formation of nuclei.





STANDARD REFERENCE MATERIALS



Standard Reference Materials are well-characterized materials disseminated by NBS to be used in calibrating and evaluating measuring instruments, methods, and systems or to produce scientific data that can be referred readily to a common base. These materials are certified for chemical composition or for a particular physical or chemical property. They are used on-site in science and industry for calibrating the instruments and methods used for production and quality control of raw materials, chemicals, metals, ceramics, fuels, and radioactive nuclides in manufacturing processes and in research. This column regularly reports on the issuance of new and renewal Standard Reference Materials and on latest developments in the Standard Reference Materials Program.

The Bureau has recently made available a renewal of a cerium-139 gamma-ray point source standard, a series of four new carbohydrate standards, and a series of carbon-14 and tritium labelled sugar standards.[1]

CERIUM-139 GAMMA-RAY POINT SOURCE

A cerium-139 gamma-ray point source, NBS Standard No. 4999D, has been certified and is available for purchase in units which had approximately 2 x 10^5 nuclear transformations per second per unit at the time of certification. This standard costs $65 per unit.[2] NBS No. 4999D can be shipped via express collect only to destinations in the United States and Canada. Purchasers outside these countries should apply to NBS for *pro forma* invoices.

The standard consists of cerium-139 deposited, as the chloride, on polyester tape approximately 0.006 centimeter thick and covered by another layer of the same tape. The activity of the source was determined by comparing it, through gamma-ray emission-rate measurements, to reference sources prepared from a master solution which had been calibrated by means of the NBS $4\pi\gamma$ ionization chamber which had been calibrated previously by $4\pi x$-γ coincidence counting. NBS No. 4999D was prepared and calibrated by members of the Radioactivity Section, under the direction of W. B. Mann, in the NBS Institute for Basic Standards.

Cerium-139 is an accelerator-produced radionuclide, available carrier free. It is an electron capturer with a low-energy gamma ray, the emission rate of which may be accurately standardized. Cerium-139 has been used as the diluting radioisotope in radioisotope dilution, specifically in the analysis of cerium-144 in vegetable samples. With such an application, one can better evaluate the potential hazard of fission products in the food chain. Cerium-139 can be used in studies of the mechanisms of cerium uptake. It is useful in studies of the mechanisms of radiation injury and "metal metabolism." Cerium has been shown to involve the protein and carbohydrate metabolism of the liver. With a half-life of 138 days, cerium-139 decays by orbital electron capture to a single excited state of lanthanum-139, a 166-keV level which has an internal conversion coefficient of 0.25.

The cerium-139 standard provides a low-energy (166 keV) gamma-ray standard for the accurate calibration of detectors and gamma-ray spectrometers which are used in such areas as activation analysis and radioactive tracing.

CARBOHYDRATES ISSUED

The NBS Office of Standard Reference Materials is now making available four carbohydrates as reference standards. They are 2,3-*o*-isopropylidene-β-D-*threo*-pentulose ("monoacetone-D-xylulose"), 1,2-*o*-isopropylidene-β-L-idofuranose, quebrachitol, and *levo*-inositol. These are rare compounds that are not available from commercial suppliers; they are representatives of a range of synthetic and naturally occurring compounds that have been studied at the Bureau. Requests have been received in the past from scientists in need of such compounds as reference standards for facilitating identifications of unknown substances by comparisons of physical and chemical properties or for use as standards for analysis. New supplies of the four compounds were needed, and these are now issued as Standard Reference Materials.

2,3-*o*-Isopropylidene-β-D-*threo*-pentulose

D-*threo*-Pentulose (synonyms: "D-lyxoketose, D-lyxulose, D-xyloketose, D-xylulose") as a 5-phosphate derivative occurs as an intermediate in photosynthetic and metabolic processes. A crystalline form of the free sugar has

n been reported; for this reason, the standard sample p vides the sugar in the form of a stable crystalline de- ri ative, which is readily hydrolyzed on warming in dilute o lic acid. (The acid is subsequently removed by treatm nt with calcium carbonate.)

1,2-*o*-Isopropylidene-β-L-idofuranose

Neither mirror image form of idose is known as a crystalline substance, and, as a syrup, this aldohexose is unstable, being transformed spontaneously into sorbose (a reaction ordinarily catalyzed by alkali). In aqueous acid, the sugar forms an equilibrium mixture with its 1,6-anhydride. Consequently, the standard provides a crystalline idose derivative that is stable, but which, by mild hydrolysis in acetic acid, is transformed into L-idose. Lyophilization then provides the syrupy sugar at optimal purity.

Quebrachitol

This carefully purified compound is issued as a standard reference material for investigators who are concerned with the identification and analysis of the chemical components of plants and trees, in which quebrachitol, a monomethyl ether of *levo*-inositol, is found widely distributed.

levo-Inositol

Demethylation of quebrachitol was used for the preparation of the *levo*-inositol standard. Like its precursor, *levo*-inositol occurs in the vegetable kingdom; but it occurs also as a racemate (equal proportions of the *dextro*- and *levo*-inositols). Chromatographically, *levo*-inositol and *rac*-inositol behave identically, and the standard is therefore not useful for distinguishing the racemate from the optically active isomer. However, the physical properties of the crystalline materials or their optical rotations serve to distinguish them.

RADIOACTIVE CARBOHYDRATES

For several years, NBS has been the sole source of a number of radioactive carbohydrates labeled at specific positions with carbon-14 or tritium. These labeled compounds were synthesized, by methods developed by H. S. Isbell and his associates in the Organic Chemistry Section of the Bureau, to meet the need, unfilled elsewhere, for such reagents for use in chemical and biochemical analysis. Some of these position-labeled radioactive carbohydrates are now supplied commercially. By having an isotope's distinctive properties associated with a compound, chemists are able to employ sensitive isotopic techniques (a) to obtain analyses specific for that compound (by isotope-dilution methods) or (b) to follow complex reactions in which the compound may be rearranged, cleaved, or transformed into several products. In the latter processes, the fate of the labeled portion of the structure of a compound can be followed. Such complex processes can be more completely analyzed by studying, in addition, the reactions of the isotopic compound having other positions labeled; hence, some of the sugars have been synthesized with labeling in alternative positions.

The ^{14}C-labeled sugars available include: D-arabinose-*1*-^{14}C, D-arabinose-*5*-^{14}C, L-arabinose-*1*-^{14}C, D-galactose-*1*-^{14}C, D-galactose-*2*-^{14}C, D-galactitol-*1*-^{14}C, D-glucose-*1*-^{14}C, D-glucose-*2*-^{14}C, D-glucitol-*1*-^{14}C, D-glucose-*6*-^{14}C, D-glucuronic-*6*-^{14}C lactone, sodium D-glucuronate-*6*-^{14}C, lactose-*1*-^{14}C, D-lyxose-*1*-^{14}C, maltose-*1*-^{14}C, D-mannose-*1*-^{14}C, D-mannonic-*1*-^{14}C lactone, D-mannitol-*1*-^{14}C, L-rhamnose-*1*-^{14}C, D-ribose-*1*-^{14}C, D-xylose-*1*-^{14}C, D-xylose-*2*-^{14}C, dextran-^{14}C, and inulin-^{14}C. The ^{3}H-labeled sugars include: D-glucose-*1*-*t*, D-mannose-*1*-*t*, D-mannose-*6*-*t*, L-sorbose-*1*-*t*, L-sorbose-*6*-*t*, and D-xylose-*5*-*t*. However, only those labeled compounds that are not now obtainable from commercial sources are being supplied by the Office of Standard Reference Materials.

Prices are $12.50 per 10 microcuries (μCi) for the 1-^{14}C-labeled sugars and labeled polysaccharides, $17.50 per 10 μCi for the 2- and 6-^{14}C-labeled sugars, and $12.50 per 10 μCi for the sugars labeled with tritium.[2] It should be noted that these substances are not intended for use as radioactivity standards.

OVERSEAS STANDARDIZATION ACTIVITIES

For many years, the Bureau has had close scientific contacts with scientists abroad having related interests. It has supported research projects in India, Israel, and Pakistan, where there has been authority to issue scientific grants and contracts. These are financed from unused balances of local-currency funds accruing to the United States from the sale of agricultural commodities.

Within the past year, the decision was made to explore the possibility of concentrating these funds in three areas important to NBS, namely: Standard Reference Materials, Standard Reference Data, and Engineering Standards and Measurements. W. W. Meinke, Chief of the Office of Standard Reference Materials, was a member of a group that visited these three countries to explore possible areas of competences and interests that might provide a basis for fruitful collaboration in the field of Standard Reference Materials. In each country, considerable interest and competence was found. Proposals are already being evaluated on projects that might be supported with local-currency funds in the area of Standard Reference Materials preparation.

[1] For a complete list of Standard Reference Materials available from NBS, see Standard Reference Materials: Catalog and Price List of Standard Materials Issued by The National Bureau of Standards, NBS Misc. Publ. 260, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 45 cents. Quarterly insert sheets which up-date Misc. Publ. 260 are supplied to users on request.

[2] These standards may be purchased for the price indicated from the Office of Standard Reference Materials, National Bureau of Standards, Washington, D.C. 20234.

278-178 O—67——2

AUTOMOTIVE SAFETY RESEARCH EXPANDED AT NBS

■ The automobile is involved each day in injuries to more than 9,000 Americans and in death to more than 140. Its growing role in American life and the alarming proliferation of accidents have spurred recent legislation aimed at increasing safety on the Nation's highways.

Weak points in automotive equipment are the particular targets of the National Traffic and Motor Vehicle Safety Act of 1966. As a consequence the National Bureau of Standards has greatly expanded its research on systems affecting automotive safety. This work is being performed under the direction of Paul J. Brown in the Office of Vehicle Systems Research of the NBS Institute for Applied Technology, with support from the Department of Transportation's National Highway Safety Bureau.

NBS had previously conducted extensive research on combustion of fuels in automotive engines,[1] as a function of engine design and the fuel used; this work was of particular significance in compounding fuels for minimum engine knock and in standardizing fuel "octane" ratings. Other NBS automotive work included studies of gear wear [2] with various lubricants and the testing of tires,[3] brake fluids, and seat belts.[4]

The new NBS program will continue to deal with tires, brakes, and seat belts, but will be enlarged to include research on their system functions as they relate to safety performance. The main purpose of the program is to provide a basis for mandatory standards which will be issued by the Department of Transportation.

Tire Systems Research

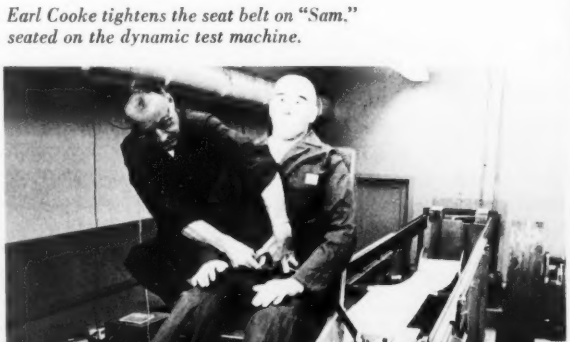
Automotive tires can be tested to determine their dependability and durability in several ways—on the road, on machines simulating use, and by laboratory examination of materials and construction. Testing by such methods will be continued, but new research is needed to validate present test procedures and to set up new and more effective ones. This research is particularly needed because of the introduction of new materials and manufacturing methods, the sustained high speeds at which tires are used on today's expressways, the opportunity of improving test instrumentation, and the spreading use of poorly understood tire descriptions, as well as to statistically compare modes of failure.

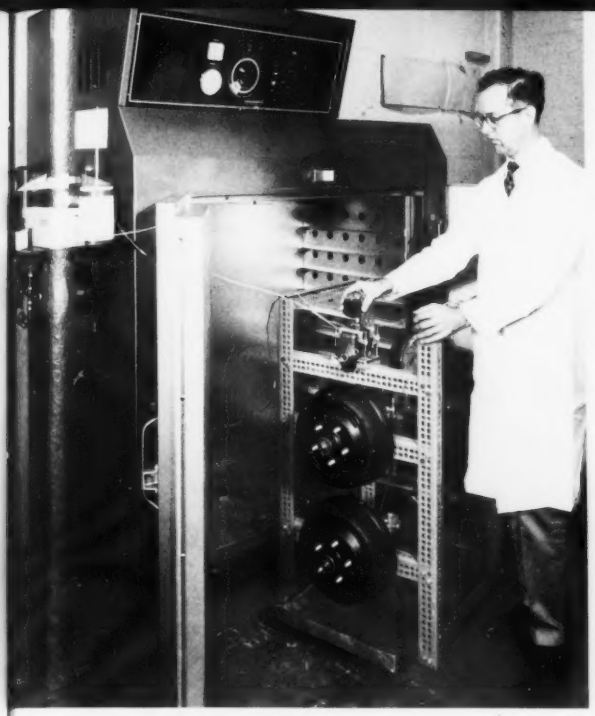
A broad investigation of tire life and failure will start with basic studies of the behavior of tires, using such advanced methods of mechanics as mathematical models of tire stresses. A present bias–ply tire model will be used to study the stress distribution of a rolling tire deformed under load as related to material properties, fabric strength, carcass shape, and other variables.

The digital computer will be used to simulate the phenomena of tire skidding and hydroplaning. Other laboratory methods are being developed to define failure mechanisms by means of simulations in which tire geometry and use conditions can be varied.

New instrumentation is being developed at the Bureau to monitor such tire variables as rubber temperature, air temperature, and inflation pressure during road and track testing. The road testing will be contracted for and supervised by NBS.

Earl Cooke tightens the seat belt on "Sam," seated on the dynamic test machine.





Jack Harvey pours a measured amount of brake fluid into a master cylinder reservoir serving the brakes of four "wheels."

The growing use in merchandising of an undefined "ply rating" unit and descriptors such as "premium" and "first line" has established the need for a uniform tire grading system. Under the law, such a system is to be established by late 1968. More immediate objectives of the tire program are safety performance standards for original–equipment and replacement passenger–car tires, and for truck and bus tires. This will be followed by development of safety performance standards for used and retreaded tires.

Another approach now being pursued consists of compiling statistics, from selected areas of the country, to determine how tires are used and the nature of failures resulting in warranty adjustments. These data will be used to set up valid measures of tire performance, such as tread life, carcass strength, braking and traction capability, and cornering behavior. They will have obvious applicability in selecting useful criteria of tire durability and the rigor needed in testing.

Occupant Restraint Systems Research

The static test for seat–belt assemblies, covering factors of tensile strength, color fastness, and abrasion resistance, was originally developed by NBS under specific seat–belt legislation.[4] Now the need is for study of both seat belts and upper torso restraints—harnesses—in simulated collisions.

Even before the present auto safety legislation, NBS was assembling a dynamic device for testing seat belts in simulated collisions and sudden stops. Such devices are used by some manufacturers and by a few consumers, such as the Air Force. One goal of this project is to develop a test device that is inexpensive enough to be acquired or built by more seat-belt manufacturers.

The dynamic testing machine consists, like others, of a sled mounted on tracks. A dummy simulating an auto passenger is attached to the sled by the restraining system under test. The sled is snatched backwards from its starting position by a heavy fabric belt when the drum to which the belt is attached is revolved. This occurs when a positive–acting clutch suddenly couples the drum to a high–inertia rotating system. The drum has a special cam which applies the desired deceleration pulse.

The forces on the dummy and restraining system are at a maximum at the instant the sled is jerked backwards; they are measured by strain and pressure gages attached at the desired points. Deceleration is applied to the sled part way down the track; two independent braking systems are used for safety during operation.

Factors that will be evaluated by use of this machine include critical impact angles, anchorage locations, seat configurations, and effect of subject articulation. Modified deceleration patterns and self-compensating rates of energy absorption will also be studied. Of interest are the clearances required for occupant movement in collision.

The seat–belt program is expected to be of use in ways other than testing new restraining systems. Efforts will be made to seek out factors that will result in greater use of seat belts by the public. Long-range research will include the development of inspection methods for seat belts and harnesses after they have been used. Also, the investigators plan to study how to make specialized test dummies that are inexpensive and, at the same time, produce the proper reaction in restraint systems.

Braking Systems Program

Work on braking systems will include the expanded testing of brake fluids, at a new, larger laboratory now being set up in Washington. Brake lining performance also will be investigated.

Determining requirements that will insure the safe performance of the elements of the brake system is a first step toward insuring the safe performance of the entire brake system. A special inertia brake dynamometer for testing complete braking systems will be installed later this year.

Studies of brake systems will be rounded out by road performance tests, to be performed under contract with NBS and supervised by Bureau personnel. The data obtained will be evaluated for correlation with results of laboratory tests. Plans for the future include use of a systems analysis approach in developing mathematical models of braking systems.

Research Information Exchange

NBS motor vehicle safety research parallels present

continued

SAFETY *continued*

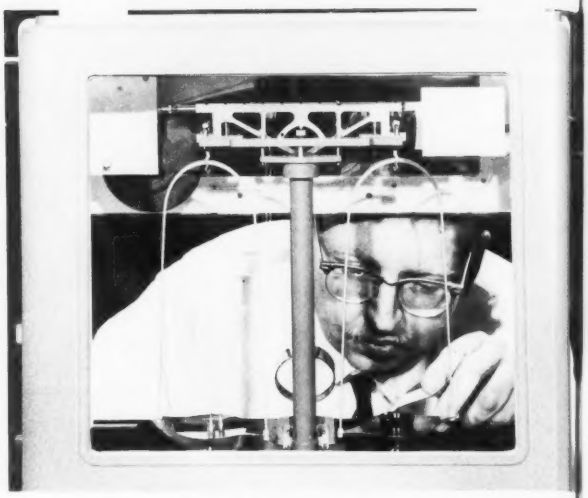
research in automotive industries, a considerable part of which is never described in formal publications. In an endeavor to prevent needless repetition of efforts and to speed research benefits, the NBS Office of Vehicle Safety Research is compiling a listing of literature on automotive research. This will be of use to both NBS and industrial laboratories. It will help them apply their resources of manpower, time, and funds to reduce injuries and deaths resulting from motor vehicle accidents.

[1] Isotopic tracer study of cool-flame oxidation: Separation of cool-flame combustion products, NBS Tech. News Bull. **42**, 150–151 (Aug. 1958); New data on automotive combustion: Research on the nature of engine knock, NBS Tech. News Bull. **37**, 113–115 (Aug. 1953); Research on engine knock, NBS Tech. News Bull. **35**, 129–131 (Sept. 1951); and Automotive research, NBS Tech. News Bull. **31**, 139–143 (Dec. 1947).

[2] Laboratory wear test for automotive gear lubricants, NBS Tech. News Bull. **33**, 79–81 (July 1949).

[3] Power loss of tires, NBS Tech. News Bull. **44**, 190–192 (Nov. 1960); and Laboratory method for measuring tire tread wear, NBS Tech. News Bull. **44**, 209–210 (Dec. 1960).

[4] Auto seat belt standard set, NBS Tech. News Bull. **49**, 30–31 (Feb. 1965); and Auto seat belt standards revised, NBS Tech. News Bull. **49**, 145 (Sept. 1965).



A wheel cylinder part from an automobile braking system is being weighed by Lewis Milliken in preparation for durability testing.

STANDARD FOR MAGNETORESISTIVE DEVICES

■ A new standard for describing magnetoresistive devices has been developed by the NBS Institute for Applied Technology for the Navy for use as a Military Standard in procuring these devices.

Formerly a laboratory phenomenon, magnetoresistivity has recently come into greater prominence with improvement in semiconductor fabrication techniques and with the growing variety of components finding use in today's instruments. Components using this effect range from the obvious—noncontacting switches and variable resistors—to the sophisticated—sensing mechanisms for traffic control and guidance pickups for trackless vehicles.

The standard terminology, letter symbols, and circuit symbols in the new standard were formulated by Sherwin Rubin of the NBS staff. They have been adopted by the Naval Air Systems Command as the first step in setting up a triservice procurement standard. The standard will not only be useful in military procurement, but will encourage uniformity in civilian treatment as well.

Present practices of magnetoresistor manufacturers and users were investigated in compiling the standard, in order to make it of maximum use in government, industry, and institutions of learning. Happily, broad agreement characterizes present usage in the United States and the standard is expected to ease any logistics problems arising with increased procurement and use of these devices.

A magnetoresistive device has a resistance that can be changed by varying the strength of the magnetic field passing through it; the stronger the field the greater the resistance. Such a device can be a thin wafer of semiconductor material having leads from two opposing edges; when voltage is applied across the leads, current flows across the wafer in more or less straight paths. When a magnetic field cuts the current paths, however, the carriers are forced toward one side of the wafer. Since each deflected path is, in general, longer than the unmagnetized path, it has greater resistance. The increased path length and greater current density have an effect the same as an increase in the resistivity of the device's material.

The increasing use of magnetoresistive devices creates a present need for the standard in order to prevent confusion and facilitate procurement. The standard defines basic quantities, symbols, and terminology, and also describes a current noise test setup and procedure. A similar standard had already been developed by the same NBS group for Hall effect devices to facilitate Naval procurement.[1]

[1] New standard for Hall devices, NBS Tech. News Bull. **49**, 107 (July 1965).

STANDARDS AND CALIBRATION

CALIBRATION OF GRENZ RAYS

To meet the needs for x-ray calibration service for instruments in the soft or Grenz-ray region, a free-air ionization-chamber standard suitable for this part of the x-ray spectrum has been constructed by the NBS Institute for Basic Standards. Construction details together with the results of comparisons of the new chamber with the NBS "low-energy" free-air chamber have previously been given by P. J. Lamperti and H. O. Wyckoff.[1] Direct comparison of the Grenz-ray chamber has also been made with a free-air chamber at the International Bureau of Weights and Measures (Sèvres, France), and those results will be published shortly.

The radiation qualities for which calibration service is offered in the Grenz-ray region are 10 and 15 kVcp (=kilovolts constant potential) with a total filtration of 1 mm Be plus 19 cm air, having half-value layers of 0.024 and 0.035 mm Al, respectively. A complete listing of NBS x-ray calibration services is contained in NBS Miscellaneous Publication 250, *Calibration and Test Services of the National Bureau of Standards*, available at $1.00 per copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz
WWVH—2.5, 5.0, 10.0, and 15.0 MHz
WWVB—60 kHz

Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. Adjustments are made at 0000 UT on the first day of a month. *There will be no adjustment made on 1 December 1967.* The pulses occur at intervals that are longer than one second by 300 parts in 10^{10} due to an offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France.

Radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS–III) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on 1 December 1967. The seconds pulses emitted from WWVB will be retarded 200 ms.*

CALIBRATION OF OPTICAL TEMPLATES IMPROVED

The NBS Institute for Basic Standards reports a notable advance in the accuracy with which it calibrates master templates used by optical firms and others in the shaping of lenses. The templates are glass plates having accurately measured curvatures; they are used by lens grinders to determine when design specifications are achieved.

For some years NBS has calibrated radius-of-curvature masters, reporting values with uncertainties of ± 50 micrometers (microns). The recent advance is a consequence of improvements in equipment, plus a thorough statistical analysis of data taking and processing, which have reduced the uncertainty by 25 times, to ± 2 micrometers. This improvement in calibration will permit the fabrication of optical systems with correspondingly improved performance.

STEP-GAGE CALIBRATION MADE FASTER

By the addition of a few accessories, the NBS automatic fringe-counting interferometer has been adapted for calibrating a step gage of one type used as an engineering and machine-shop standard. For those step gages whose geometry is compatible with this equipment, the method can be used for a calibration related directly to the wavelength of light, rather than indirectly through gage blocks. The automatic interferometer was originally developed by the National Bureau of Standards for calibrating line standards.[2] While it is still so used, it is now proving its versatility.

[1] NBS free-air chamber for measurement of 10 to 60 kV x rays, J. Res. NBS **69C** (Engr. and Instr.), 39–47 (Jan.–Mar. 1965).
[2] Line-standard interferometer, NBS Tech. News Bull. **51**, 43 (Mar. 1967).

CLEARINGHOUSE
FOR FEDERAL SCIENTIFIC AND TECHNICAL INFORMATION

Focal Point in Government for Technical Information for Industry

The Clearinghouse for Federal Scientific and Technical Information supplies the industrial and technical community with information about Government-generated science and technology in defense, space, atomic energy, and other national programs. This facility, a part of the NBS Institute for Applied Technology, is a focal point for the results of unclassified Federal research and development.

The Clearinghouse collects, announces, sells, and references unclassified technical reports and translations produced by all Government agencies. During the last fiscal year in which approximately $16 billion was spent on Federal research and development, the Clearinghouse collected some 50,000 research reports and translations. A large proportion of this work came from the Department of Defense, the National Aeronautics and Space Administration, and the Atomic Energy Commission. The Clearinghouse disseminated over two million copies of these reports.

The Clearinghouse now processes, announces, and distributes all unclassified and unlimited Department of Defense documents to defense contractors—functions formerly performed by the Defense Documentation Center. Contractors continue to make their requests for documents to the Center, but the orders are filled by the Clearinghouse.

Widening the Exchange of Technical Information

A recent change in the Department of Defense policy of announcing DoD research and development documents widens the exchange of technical information. Under the new policy, announcements of DoD scientific and technical reports appear in the Clearinghouse journal, *U.S. Government Research and Development Reports* (USGRDR), and are no longer published in the Defense Documentation Center's (DDC) *Technical Abstract Bulletin* (TAB). TAB carries a security classification of confidential and announces only classified or controlled reports. It is available only to organizations that are accredited for classified service. An earlier agreement between the Clearinghouse and DDC in 1964 eliminated duplicate processing of the reports themselves.

Approximately 20,000 DoD reports are approved each year for public release and sale. These reports are now announced only in USGRDR which also announces over 15,000 reports from NASA, AEC, and other agencies. The new policy will promote wider exchange of unrestricted technical information by providing direct exposure of the DoD contractor community to the thousands of non-DoD reports available to the public.

What Is Available From the Clearinghouse?

The Clearinghouse, through its publication, *U.S. Government Research and Development Reports*, announces new Government research and development reports released for sale to the public. Each issue covers over 1,000 new documents; document entries are arranged by subject matter under 22 headings. USGRDR comprises the total R&D report input to the Clearinghouse and is issued twice a month, on the 10th and 25th. It is sold by the Clearinghouse on a subscription basis for $30 a year ($37.50 foreign) or as single copies for $3. This publication features a format that allows quick scanning of reports by title. USGRDR cross references include title, price, and corporate author. An edge index locates specific subject fields quickly and, if the accession (stock) number is known, a report locator list leads the user to the report. *Government-Wide Index to Federal Research & Development Reports* (GWI) indexes the USGRDR. Documents are indexed by subject, author, source, report number, and contract number. GWI is issued twice a month, concurrent with USGRDR, and is sold by the Clearinghouse on a subscription basis for $22 a year ($27.50 foreign) or as single copies for $3.

A *Fast Announcement Service* (FAS) rapidly informs subscribers of selected new R&D reports. All documents acquired by the Clearinghouse are reviewed by technologists; approximately 10 percent are selected for their industrial significance. These reports are described in Fast Announcements with emphasis, where possible, on commercial applications. Announcements are written and mailed by a subject system of 57 categories. Fast Announcements serve as "flash sheets" to bring immediate attention to selected reports. Frequency of issue depends upon input of new documents, their categories, and selection by the evaluators. Subscriptions to the Clearinghouse Fast Announcement Service cost $5 per year for any or all 57 categories. Anyone interested in this service should request a special application form from:

The Clearinghouse, NBS
Sales Desk (410.12)
U.S. Department of Commerce
Springfield, Va. 22151

How To Order Reports

Documents announced in USGRDR and FAS may be purchased from the Clearinghouse in two forms—paper copy or microfiche. Paper copy is produced by offset printing or by "blowback" from microfiche. A microfiche is a 4 by 6 in. sheet of film, containing up to 70 document pages. Microfiche are considerably less expensive than paper copies and easier to handle, store, and reproduce. Almost all of the documents in the Clearinghouse collection are priced at $3 for paper copies and at 65 cents for microfiche. The Clearinghouse single price, prepaid document coupon system for paper copies and microfiche provides faster, more efficient service on document requests. The prepaid coupon is the payment, order form, shipping label, and receipt of sale. Coupons for paper copies of documents are available from the Clearinghouse at $3 each or in books of 10 coupons for $30. Coupons for microfiche are available at 65 cents each or in books of 50 for $32.50.

ADVISORY COMMITTEE ON THERMOMETRY MEETS AT NBS

Members of the Advisory Committee on Thermometry to the International Bureau of Weights and Measures, together with other specialists on thermometry, met at the National Bureau of Standards, September 6 to 9, at Gaithersburg, Md. Delegates from Australia, Canada, England, France, Germany, Japan, the Netherlands, Russia, and Spain participated in discussions and toured the NBS thermometry laboratories. The Thermometry Committee is responsible for monitoring and evaluating current research on temperature scales for the purpose of generating specific recommendations to the General Conference on Weights and Measures. The international standardization resulting from such recommendations allows interchangeability of data, thus eliminating a great deal of experimental duplication.

Advisory Committee: (left to right, front row) Mme. M. P. Orlova, Physicotechnical and Radiotechnical Measurements Institute, U.S.S.R.; C. R. Barber, National Physical Laboratory, Teddington, England; Prof. J. deBoer, Institut Voor Theoretische Fysica, University of Amsterdam, Netherlands; M. J. Terrien, Director, International Bureau of Weights and Measures, Sèvres, France; Dr. F. G. Brickwedde, Committee Chairman, Pennsylvania State University; Dr. H. Van Dijk, Kamerlingh Onnes Laboratorium der Rijksuniversiteit te Leiden, Netherlands; Dr. Seiji Takata, National Research Laboratory of Metrology, Tokyo, Japan; (second row) Dr. M. Durieux, Kamerlingh Onnes Laboratorium der Rijksuniversiteit te Leiden; Dr. T. J. Quinn, National Physical Laboratory; A. Moser, Conservatoire National des Arts et Métiers, Paris, France; J. A. Hall, International Bureau of Weights and Measures; Dr. M. Colomina, Instituto de Química Física, Madrid, Spain; Prof. C. A. Swenson, Iowa State University; Dr. H. Moser, Physikalisch-Technische Bundesanstalt, Braunschweig, Germany; (third row) Dr. H. Preston-Thomas, National Research Council, Ottawa, Canada; R. Bedford, National Research Council; Dr. L. A. Guildner, NBS; J. L. Riddle, NBS; Dr. H. H. Plumb, NBS; Dr. A. F A. Harper, National Standards Laboratory, Australia; B. Oleinik, Deputy Director, Institut Metrologii Mendeleeva, Leningrad, U.S.S.R.; and, Dr. R. P. Hudson, Chief, NBS Heat Division.

NSRDS NEWS

This column regularly reports significant developments in the program of the National Standard Reference Data System. The NSRDS was established in 1963 by the President's Office of Science and Technology to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the National Bureau of Standards through the NBS Office of Standard Reference Data, located in the Administration Building at the NBS Gaithersburg Laboratories.

Results of *Industrial Research* Survey on Requirements for Physical Properties Data

Industrial Research magazine cooperated with the Office of Standard Reference Data recently to conduct a survey to determine: [1]

1) Data and information needs of scientists and engineers within the industrial research community.
2) How such needs are now met.
3) Patterns of use of data, information, and reference sources.
4) Problems in finding required data and information.

From the response of about 600 scientists and engineers, the survey revealed that:

1) Seventy-five percent experience problems in locating or obtaining materials properties data.
2) During a typical week, 55 percent look up properties data from 1 to 5 times; while for others, the task is more demanding—occurring 6 to 10 times for 22 percent and more than 10 times for 19 percent.
3) Generally, the majority locate the necessary information in less than an hour. However, 24 percent spend from 1 to 8 hours, and 8 percent may search for days or weeks.

Among other items of interest revealed by the survey were:

1) Sources of data on properties of materials most often consulted are (in percentages): (a) handbooks—94; (b) books—70; (c) literature searches—60; (d) technical libraries—57; (e) periodicals—53; and (f) company data files—50.
2) Formats most frequently used and preferred are (in percentages): printed book—83; printed article—76; reproduced loose sheets—36; microfilm—9; and computer printout—7.
3) Nearly three-fourths of the scientists and engineers require and use bibliographies in their work.

Eighty-two percent of the respondents were engaged in research and development; manufacturing and processing accounted for 18 percent; while other groupings made up 20 percent. The disciplines represented were (in percentages) chemistry—37; engineering—32; physics—12; the life sciences—8; and miscellaneous—11.

Storing Machine-Readable Records

Widespread and increasing dependence on computers to assist the technical community in developing, manipulating, and printing scientific information means that greater use is being made of data stored in a machine-readable form. The storage of machinable data, particularly for archival purposes or for infrequent use, raises the question of the reliability and permanence of the storage medium.

The Office of Standard Reference Data expects to rely heavily on computer methods in the future and, consequently, will be confronted with the problem of storing computer usable records over extended periods. Also, a number of NSRDS publications (bibliographies and data compilations) prepared by computer-aided photocomposition may be retained in machine form for updating and republication. For these reasons, the Office is concerned with problems related to the storing of machine-readable records.

The computer oriented storage media commonly used by the technical community are punched cards, paper tape, and magnetic tape. Of these, magnetic tape is most generally preferred because it is compact, easily handled, relatively inexpensive, and usable on hardware available at most computer installations.

Magnetic tape, however, has limitations. Recordings on a reel of tape tend to transfer their images to overlying portions of the tape that are in contact with them. Often, after about 15 to 18 months of storage, sufficient image transference occurs to destroy inter-record gaps. This obliterates distinctions between records and renders the information on the tape virtually useless. Another limita-

tion is that tape handling units are modified by repeated adjustments or replaced by improved models, with the result that tapes produced a year or more earlier may not run on the modified or changed unit.

There are established procedures for avoiding the limitations described above, but many computer installations are unacquainted with these problems or leave their solution to the individual computer user. At the very least, magnetic tapes to be stored for a number of years should be unwound and rewound each year. A better practice would be to produce a new tape each year.

For machine-record storage applications of small volume, punched paper or mylar tape may be satisfactory. Approximately ten 700-foot reels of punched tape can store the data from a medium density (approximately 500 frames per inch) magnetic tape that has data recorded on half its 2400-foot length. Successful use of paper tape for this application would require the proper equipment and a well designed system. However, the recorded information should remain unaltered and available for use after many years of storage.

Punched cards share some of the advantages of paper tape, but they are more bulky, are subject to greater physical deterioration, and are susceptible to having random records destroyed or misplaced.

New developments indicate the possibility of better long term storage of machine-readable records. Photographs of magnetic recordings (bit images) made by monochromatic laser beams might be valuable to computer users as large-capacity, long-term storage occupying about as much space as medium density magnetic tape. Photographic film of this type could be read by laser beams into a computer for processing. This type of storage has been named read-only memory.

If such laser devices become readily available at a cost competitive with magnetic tape, a significant advance in the state of the art will have occurred benefiting all computer users.

Is the Printed Page Obsolete?

As readers of the *NSRDS News* are aware, the Office of Standard Reference Data and its associated data centers have been concerned with the development of systems for more effective processing of information and data from point of generation to point of end-product. As more and more data centers in the program begin the development of actual mechanized systems or study the feasibility of a mechanized system for their activity, they are coming to face not only the problems they experience or will experience in mechanized procedures, but also the problem of the form or package of the information and data product of their efforts—be it computer paper tape, magnetic tape, print-out, punched card, microfiche, or microfilm.

The state of technology has advanced to the point that some observers have concluded that the printed page as an information transfer medium is obsolete. Such views are not unchallenged, because users of information and data prefer the older formats. (Note, for example, the *Industrial Research* survey, discussed above, which revealed readers' preferences; note also the problems involved in storage of computer magnetic tapes in the preceding item.) The debate is vigorous.

The following excerpt from a paper by Y. S. Touloukian, Director, Thermophysical Properties Research Center, Purdue University, presented at the Annual Meeting of the American Institute of Aeronautics and Astronautics, October 23, 1967, offers a good examination of the issues and should be of interest to workers in the data and information field.

"Since the beginning of modern civilization, the printed page has served as the basic medium for the storage and dissemination of information. I wish to contend that this medium will continue to be, for a long time in the future, the prime mode of communication. This contention, however, does not imply that the format of this mode of communication will be the same in the future as it is today.

"This very topic could easily be a major area for extensive discussion in its own right. My purpose in bringing up the subject is not to dwell on it in any great detail but simply to point out certain misconceptions which have disturbed the user of technical information who has a great stake in the various modes of communication with which he interacts . . .

"In the not too distant future, we can expect substantial changes to take place also in the publication format of the conventional scientific and technical journal as well as its mode of dissemination. As the cost of these journals continues to increase, once again national scientific and technical societies as well as publishers will be forced to take a harder look at the facts and decide if what was adequate yesterday is still par today. The questions of 'what is worth printing,' 'what is worth retrieving,' and 'what is worth reading' are no longer rhetorical forms and are being asked more and more frequently each year. Along similar lines, we are already aware of the revolutionary changes that are taking place in copy production and transmission where the computer once again is playing a central role as a tool.

"Among all of these swift currents, in recent years certain sources have revealed that 'studies of communication habits among engineers and scientists show that their prime mode of communication is verbal and personal and not the printed document.'

"The promotion of such a notion has indeed had beneficial results to engineers and scientists as it has stimulated among a number of governmental agencies more generous funding for travel to meetings and conferences. While I can hardly object to such a policy, I must state without reservation that the so-called 'factual finding' stated above is without sound basis, nor is it true in principle. The fact that an engineer finds it more convenient to query his of-

NSRDS NEWS *continued*

ficemate or the fellow down the hall for his information needs does not infer that he gets the information he seeks nor that he obtains the correct information. Indeed, one may ask where his officemate obtains his information. A truer diagnosis of the situation would be that our engineer finds it difficult to have quick access to the proper information sources or more often he is not aware of the availability of these sources. His action rather represents a reaction to a faulty communication system resorted to through desperation. The logical answer to the problem is to make the information available in a form that is readily accessible and in scope adequate for his needs.

"On the other hand, there are those who propose to computerize the process of storage and retrieval on a large scale and dispense information on demand, tailored to the needs of the requester. To the proponents of this approach, I can present no serious arguments except to remind them that two prerequisites are necessary prior to a serious attempt in this direction. First, one must decide what it is that one wishes to store, and secondly, how many bits of information one can logically store on tape or other magnetic media. When these two factors are fully evaluated, we will see that the printed page, fiche, or film are still unmatched for storage capacity, convenience, and cost and will be around for a long time to come as the major serious means for the storage and transmission of engineering and scientific information."

Study of Computer Utilization in Spectroscopy

An Advisory Panel on the Application of Computers to the Measurement, Storage, and Retrieval of Spectral Data and the Digitization of Spectral Information met at the National Academy of Sciences on July 24 and 25. This panel is an *ad hoc* sub-unit of the Atomic and Molecular Properties Advisory Panel to the National Standard Reference Data System. Both advisory bodies function under the sponsorship of the National Academy of Sciences' Office of Critical Tables. Ellis R. Lippincott of the University of Maryland is chairman of the *ad hoc* Advisory Panel, while E. U. Condon leads the parent body on Atomic and Molecular Properties.

The July 24–25 meeting was scheduled in time to provide a preliminary review among interested scientists and to consider informal recommendations which U.S. representatives might discuss at the 9th European Congress on Molecular Spectroscopy, held in Madrid, Spain, September 10–15, when related topics were explored by members of the International Union of Pure and Applied Chemistry. Such recommendations were prepared in three areas—infrared spectroscopy, systems, and items applicable to spectroscopy in general.

Several types of scientific instruments already use direct digitization with magnetic tape or punch card recording of their output data. This is especially true in crystallography and mass spectrometry. With increasing sophistication of instruments, similar advances are developing in infrared spectroscopy and nuclear magnetic resonance spectroscopy. Direct coupling of the instrument to a small captive computer, and on-line use of a large central computer are two modes of operation already in practice. The considerations of the *ad hoc* Advisory Panel provide a basis for continuing national exploration of needs and opportunities of the scientific community in the area of computer utilization in all types of spectroscopy.

[1] See Opinion poll, Industrial Research **9**, No. 5, 107–108 (May 1967) and Opinion poll, Industrial Research **9**, No. 9, 99 (Aug. 1967).

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Journal of Research of the National Bureau of Standards

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Section B. Mathematics and Mathematical Physics. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

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